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PATENT SPECIFICATION

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AD

(54) IMPROVEMENTS IN MOULDING

(71) We, GROUP LOTUS CAR COMPANIES LIMITED, of Norwich, Norfolk NOR 92W., a British Company do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of and a mould for moulding an article. The invention is particularly but not exclusively applicable to the moulding of an article having a reinforcement structure for example a glass fibre reinforcement.

The invention accordingly provides a method of moulding an article, the method having the step of applying a vacuum to a cavity defined between separate male and female mould parts having sealing means therebetween, the cavity containing a hardenable liquid moulding material, thereby drawing the mould parts together, with relative movement thereof at the sealing means, and causing the moulding material to flow in the cavity into the shape of the article to be moulded.

The invention also provides a mould for moulding an article, the mould comprising a male and female mould part shaped to be assembled to define a cavity therebetween, a seal for sealing the cavity against atmosphere, and an aperture in one of the mould parts for application of a vacuum to the cavity, the mould parts and the seal being arranged to permit drawing of the mould parts together with relative movement thereof at the seal, and flow of hardenable liquid mould material in the cavity into the shape of the article to be moulded, in response to the application of the vacuum to the cavity.

The use of internal vacuum to draw the male and female mould parts together has the advantage that the only pressure to which the mould is subjected is atmospheric pressure acting uniformly over the whole mould surface to squeeze the moulding material into the empty parts of the cavity during the closing down of the mould and thus the mould parts need only be sufficiently robust to avoid distortion under these conditions. Glass fibre reinforced resin mould parts of light construction can thus be used.

The method of the invention finds particularly advantageous application to the manufacture of articles incorporating a reinforcement structure in the resin. For example the female mould part, after gel coating, may be lined with glass fibre, the male mould part then positioned inside the lined female part and the resin introduced then squeezed into its eventual shape. The reinforcement becomes invested with the resin in a manner analogous to conventional vacuum impregnation.

In addition to reinforcement structures, core structures or other inserts may be positioned in the mould prior to moulding. For example where a sandwich construction of core material with a layer of glass fibre reinforced resin on opposite sides is desired the female mould part is first lined with glass fibre reinforcement, one or more preformed core pieces are positioned on the reinforcement, the whole is overlaid with a second layer of glass fibre, the male mould part placed in position to close the mould and the introduction of resin and the application of vacuum proceed as before.

Preferably, the mould parts have spaced overlapping skirt portions and a rubber or other flexible sealing ring between the overlapping skirt portions in such position as to provide an effective seal to atmosphere in all positions of the mould parts in use. For gravity introduction of resin the male mould part has an inlet orifice which can be closed by a shouldered stopper after the resin has been introduced the shouldered form of the stopper preventing it from being drawn in to the mould cavity when the vacuum is applied to close down the mould to desired size.

A connection or connections for the application of vacuum preferably lead into the space between the overlapping flanges inwardly of the sealing ring. One or other of the mould parts may be provided with a groove extending round its flange and the

vacuum connection or connections disposed to open into such groove which acts as a reservoir.

The various features and advantages of the invention will be apparent from the following description of a practical embodiment thereof and manner of putting the invention into effect given by way of example and illustrated in the accompanying drawings of which:—

Fig. 1 is a cross section through a mould for performing the method of the invention in "oversize" state and the material to be moulded introduced, and

Fig. 2 is a section similar to that of Fig. 1 with the mould in fully closed state.

Referring first to Fig. 1 the mould comprises a male part 1 and a female part 2 which, as shown are shaped for the moulding of an article of simple hemispherical shape. It will be appreciated that the mould parts can be of any desired shape to define between them a cavity having the shape of the article it is desired to mould.

The male mould part 1 has, as its uppermost part in the position shown in the drawings, an outwardly extending annular flange 3 which at its outer edge is bent downwardly to form an annular skirt 4. The female part also has a flange 5 bent downwardly to form an annular skirt 6, the flange 5 being formed with a circular groove 7. A sealing ring 8 of rubber or other resilient material is disposed between the overlapping skirts 4 and 6 and is secured to one or the other skirt, preferably the skirt 6. A connection 9 for a vacuum pipe 10 is secured to the flange 5 to open into the groove 7.

At its lowest point the male mould part 1 has an inlet orifice for resin surrounded by a tubular boss 11 into which fits a shouldered stopper 12 the inner end of which is shaped to conform to the curvature of the inner surface of the male mould part so that when the stopper is fully inserted with its shouldered part firmly abutting the edge of boss 11 there is a minimum of discontinuity of the inner surface of mould part 1 at the position of the inlet orifice.

The mould parts are separable from each other and to overcome the frictional resistance to separating movement resulting from the sealing ring 8 it is convenient to include in vacuum pipe 10 a multiway valve 13 of conventional construction which can be manipulated between positions in which it respectively applies vacuum, air or gas under pressure, and connection to atmosphere to the pipe 10, so that by manipulation of the valve the mould parts 1 and 2 can be forcibly separated by air under pressure introduced between them through pipe 10.

To mould an article, any reinforcement structure required is laid in the open female mould part 2, after gel coating the inner surface thereof if required. The male mould part, also gel-coated if required, and with stopper 12 in position, is then positioned with its skirt 4 resting on the sealing ring 8. The valve 13 is manipulated to apply sufficient vacuum to the space between the mould parts to draw these parts together to the "oversize" position shown in Fig. 1. During this operation skirt 4 rides over sealing ring 8 maintaining a sliding seal around the whole periphery of the mould. Valve 13 is now operated to release the vacuum inside the mould and the stopper 12 is removed. A measured quantity of freshly mixed thermo-setting resin sufficient to form the article to be moulded is now entered into the mould through the inlet orifice uncovered by the removal of stopper 12 and the stopper is replaced and pushed firmly into engagement with boss 11. The resin introduced collects in the lower part of the oversize mould cavity as indicated at 14 in Fig. 1.

The valve 13 is again operated to apply vacuum to pipe 10 and this causes the mould parts 1 and 2 to be drawn towards each other, skirt 4 of mould part 1 sliding over sealing ring 8 to permit such drawing together while maintaining the sealed condition of the mould. As the mould parts move towards each other they squeeze the collection of resin 15 so that it spreads upwardly through the diminishing mould cavity until it reaches the level of the flange 5 of mould part 2. During this squeezing action the application of vacuum can be regulated to ensure a smooth and even spread of the resin. This is facilitated by having the male mould part formed of translucent material and ensuring that there is a detectable colour difference between the appearance of the mould where it does not contain resin and where it does contain resin. The level of vacuum required to squeeze the resin to completely fill the effective mould cavity is maintained for a period known, from the properties of the resin mix used, to be sufficient to allow the resin to set to a state where the vacuum can be released.

To remove the moulded article 15 (Fig. 2) from the mould, the valve 13 is operated to apply air under pressure to line 10 and the mould parts 1 and 2 are thus forced apart until skirt 4 is free of sealing ring 8. Thereupon the air pressure can be switched off, the mould part 1 lifted off the mould part 2 and the article lifted out of the mould.

The dwell period required before the mould can safely be opened to release the moulded article depends upon the rate at which the resin mix used will set to form sustaining state. Since however the process

time from the pint of mixing the resin to the point where the resin reaches the top of the mould cavity need only be a few minutes, fast-curing resins can be employed and the mould can thus be free for re-use in a relatively short time.

It will be appreciated that the method of the invention provides accurate control of the reinforcement to resin ratio and the wall thickness in the article being moulded and in the case of a "sandwich" type of article i.e. one having a core of different material between two skins of resin, the accuracy extends to both skins since these are formed simultaneously in a single moulding operation.

Variation of these factors can readily be effected either by varying the quantity of reinforcement used with a given quantity of resin, or varying the quantity of resin introduced for a given quantity of reinforcement positioned in the mould.

WHAT WE CLAIM IS:—

1. A method of moulding an article, the method having the step of applying a vacuum to a cavity defined between separate male and female mould parts having sealing means therebetween, the cavity containing a hardenable liquid moulding material, thereby drawing the mould parts together, with relative movement thereof at the sealing means, and causing the moulding material to flow in the cavity into the shape of the article to be moulded.

2. A method as claimed in claim 1 in which the mould parts are assembled together to define the cavity before the introduction of the material into the cavity.

3. A method as claimed in claim 2 having the steps of assembling the mould parts together in spaced relation, applying vacuum to the space between the parts to draw the parts together, and releasing the vacuum, prior to the introduction of the moulding material.

4. A method as claimed in claim 1, 2 or 3 having the step of positioning a reinforcement structure, to be invested with the moulding material, in the cavity prior to the introducion of the moulding material.

5. A method as claimed in claim 1, 2, 3 or 4 including the step of positioning a core structure, to be encased in the moulding material, in the cavity prior tc the introduction of the moulding material.

6. A method as claimed in claim 4 having the steps of positioning a core structure upon the reinforcement structure and then positioning a further reinforcement structure upon the core structure prior to the introduction of the moulding material.

7. A method as claimed in claim 4 or 5 in which the or each reinforcement structure is of glass fibre.

8. A method as claimed in any preceding claim in which a thermo-setting synthetic resin is used as the moulding material.

9. A method as claimed in any preceding claim in which the vacuum continues to be applied to the cavity until the moulded article within the mould cavity has set sufficiently to be form-sustaining, whereupon the vacuum is released and air or gas under pressure is introduced into the mould to separate the mould parts for removal of the moulded article.

10. A method of moulding an article the method being substantially as herein described with reference to the accompanying drawing.

11. An article moulded by the method of any preceding claim.

12. A mould for moulding an article, the mould comprising a male and female mould part shaped to be assembled to define a cavity therebetween, a seal for sealing the cavity against atmosphere, and an aperture in one of the mould parts for application of a vacuum to the cavity, the moud parts and the seal being arranged to permit drawing of the mould parts together with relative movement thereof at the seal, and flow of hardenable liquid mould mtaterial in the cavity into the shape of the article to be moulded, in response to the application of the vacuum to the cavity.

13. A mould as claimed in claim 12 in which each mould part has a flange extending outwardly from the periphery thereof and a skirt portion extending at right angles to the flange, the skirt portions being in spaced overlapping relation and having disposed therebetween a resilient sealing ring constituting the seal.

14. A mould as claimed in claim 13 in which the aperture is provided in the flange of one of the mould parts.

15. A mould as claimed in claim 14 in which the flange of the one mould part has a groove extending therearound, the aperture opening into the groove.

16. A mould as claimed in claim 12, 13, 14 or 15 having at least one orifice in one of the mould parts for the introduction of the moulding material into the cavity and a closure means for sealing the orifice after the introduction of the material.

17. A mould for moulding an article, the mould being substantially as herein described with reference to the accompanying drawing.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

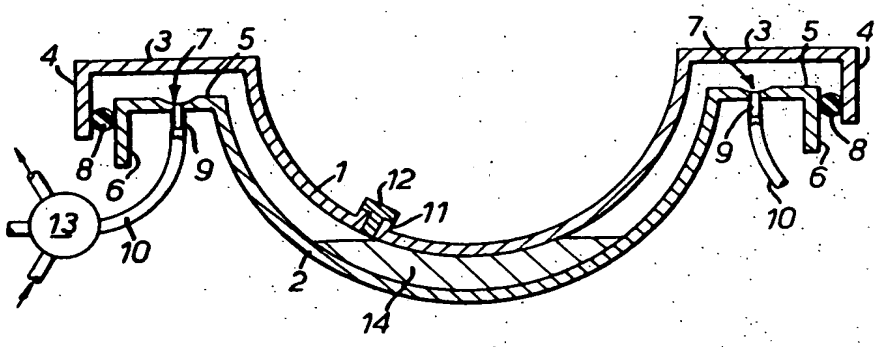

FIG. 1.

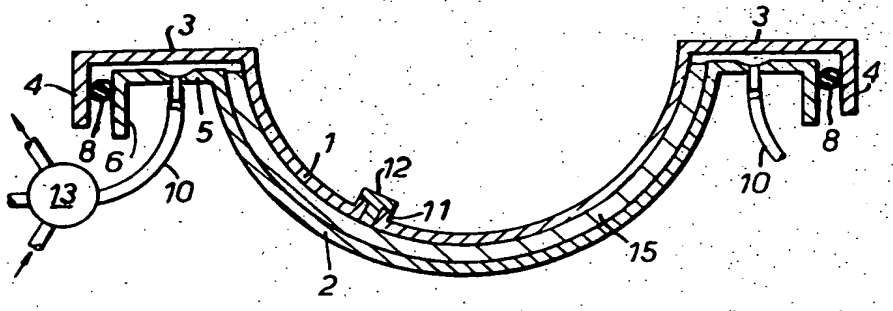

FIG. 2.